Proposed Agreement between California Energy Commission and California Institute for Energy and Environment

Title: Public University Energy Efficiency Research Projects
Amount: $3,978,590.00
Term: 42 months
Contact: Chris Scruton
Committee Meeting: 4/4/2011

Funding

FY	Program	Area	Initiative	Budget	This Project	Remaining Balance	
09	Natural Gas	Buildings	Energy Efficient Hot Water Generation and Distribution	$1,800,000	$3,034	$0	0%
09	Natural Gas	Buildings	Advanced Distribution Systems for Residential Heating	$500,000	$275,006	$0	0%
09	Natural Gas	IAW	Natural Gas Efficiency Research for Industrial & Institutional Use	$1,400,000	$400,000	$0	0%
09	Natural Gas	Buildings	NG fired and waste heat augmented heating/power systems and cooling solutions for commercial buildin	$450,000	$350,000	$0	0%
09	Natural Gas	Renewables	Develop Energy-Efficient, Cost Effective, Safe, Clean,	$463,853	$463,853	$0	0%

			Durable, and Reliable CHP and DER Technologie				
10	Electric	Buildings	Technology Innovations	$5,464,200	$1,986,500	$2,070,981	38 %
10	Natural Gas	Buildings	Energy Efficient Hot Water Generation and Distribution	$1,600,000	$500,197	$1,099,803	69 %

Recommendation

Approve this agreement with California Institute for Energy and Environment for $3,978,591.00. Staff recommends placing this item on the discussion agenda of the Commission Business Meeting.

Issue

California has enacted the Global Warming Solutions Act of 2006 (also known as AB-32). In support of this law, the California Public Utilities Commission, in coordination with the Energy Commission and the Air Resources Board, has developed the California Long Term Energy Efficiency Strategic Plan. These measures call for major reductions in greenhouse gas emissions related to California buildings and industry. Because facility occupants require a reasonable level of indoor environmental quality, these reductions will require a major improvement in energy efficiency. Research and technological development is required to meet these goals.

Background

The PIER Buildings and Industrial team invited proposals related to these policy goals from the University of California and California State University system in January of 2011. The California Institute for Energy and the Environment (CIEE) assisted with the process and will facilitate the subcontracting to each UC/CSU campus, accounting, and reporting tasks as a research entity of the University of California. Without this assistance a multi-project program of this nature would not be possible for the PIER Buildings and IAW teams.

All UC and CSU campuses were invited to participate in a teleconference on January 14 in which PIER staff discussed the program and selection criteria. On January 31, 35 short-form proposals were received, and from these 11 proposals were selected for funding, based on suitability for project funding sources, market connectedness, geographic diversification of research institution, and potential for energy savings and rate-payer benefits.

Proposed Work

The 11 proposals that are being recommended for funding are as follows:

Budget Category: Residential Heating Hot Water Systems

Project 1: Improving Heating/Cooling Systems with Phase Change Materials
PI: Mark Modera, UC Davis Western cooling Efficiency Center
Rank: 1
Amount: $275,024

Project Summary:
The goal of this 24 month project is to improve the efficiency of residential hydronic space heating and cooling systems by investigating the feasibility of adding small beads of encapsulated phase change material (PCM) to closed water circulation systems. These beads can increase the heat capacity of the water, allowing for a reduction in water flow rate for electric power savings, while increasing the heat transfer capacity of heat exchange systems. This approach could reduce the cost of new hydronic heating systems, or allow existing systems with marginally adequate heating capacities to forestall expensive upgrades. In this project, the contractor will determine the optimum material to use, test existing pumping methods with PCM beads, develop a pumping system to allow the PCM materials to pass through without damage, produce a prototype system for laboratory evaluation, and disseminate the research results through WCEC's HVAC industry affiliates and at meetings of the American Society of Heating, Refrigeration, Air Conditioning Engineers (ASHRAE). Previous work on evaluating water/PCM mixtures will be relevant to this project as UC Davis develops the idea into a practical application. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by increasing the efficiency and effectiveness of heating systems in California, thereby reducing energy use.

Budget Category: Combined Cooling, Heat, Power Non-Res
and 2010-NG Hot Water Generation and Distribution

Project 2: Solar Thermal for Efficient Combined Cooling, Heat, and Power
PI: Craig Baltimore, Cal Poly San Luis Obispo
Rank: 1
Amount: $437,564 (plus $430,000 in-kind)

Project Summary:
The goal of this 15-month project is to reduce non-renewable energy consumption in commercial buildings by developing and demonstrating the use of moderate-scale Concentrating Solar Power (CSP) in combination with traditional heat sources for Combined Cooling, Heat, and Power (CCHP) systems. CSP is well proven in large thermal power plants, and the same basic technology appears to be applicable to CCHP systems. To date no commercial suppliers or building owners have been willing to take the risk of trying it. The proposed research is the first phase of a two phase program. This phase will study the issues and challenges of deployment of the scaled-down technology by designing, building and balancing a prototype on the Cal Poly San Luis Obispo campus. The second phase is to study in depth the energy impacts of the deployment. The constructed prototype will use CSP with natural gas-backup to drive a turbine generator. Waste heat will be utilized to provide absorption cooling and/or hot water. The CSP will be a ground-mounted intermediate-scale (100 kW) heliostat and solar tower. The results of the project will confirm the technical feasibility of point-of-

use CSP/NG with CHP or CCHP, and open the path to commercialization. Project partner Buro Happold is an international engineering firm expected to commercialize the technology. The CSP equipment is to be supplied by Wilson Solarpower, which is performing related work with US DOE. Construction and equipment are to be supplied as cost share by project partners. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by increasing the use of renewable energy-driven distributed generation and building heating and cooling and also the goal of Governor Brown to develop 12,000 MW of distributed generation..

Project 3: Advanced Combined Cooling Heat and Power for Building Efficiency
PI: Scott Samuelsen, UC Irvine
Rank: 2 (also funded with 2010 PIER-E TIBC)
Amount: $385,000 (plus $60,000 in-kind)

Project Summary:
The goal of this three-year project is to develop engineering tools for designing and operating combined cooling, heat and power (CCHP) systems by analyzing, optimizing and documenting performance of an existing CCHP system using natural gas-powered fuel cells, liquid cooled photovoltaic cells, absorption cooling, heating, and thermal energy storage at UC Irvine. Although the concept of CCHP systems is widely known, a shortage of well-documented cases of system integration mean it is used much less frequently in practice than it might be. This project would document the performance of available commercial equipment, provide guidelines for component selection and integration, and provide detailed public information on performance and economics. It would help to bridge gaps in private sector experience, reducing the perceived risk of investment in this type of system, and in so doing facilitate a more efficient California energy system. The project would leverage an experienced research team at the Advanced Power and Energy Program of UC Irvine, sophisticated monitoring equipment, and existing high temperature fuel cells, an absorption chiller, and liquid-cooled solar photovoltaic equipment. Project results will be published on a website and through journal articles and conference presentations. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by promoting energy efficient heating and cooling systems and the goal of Governor Brown to develop 12,000 MW of distributed generation.

Budget Category: Hot Water Generation and Distribution

Project 4: Mini-Channel Technology to Improve Solar Water Heaters
PI: Gerardo Diaz, UC Merced
Rank: 1
Amount: $333,202 (plus $10,560 in-kind)

Project Summary:
The goal of this three-year project is to design, manufacture, test, and demonstrate the cost effectiveness of a solar water heater based on use of a mini-channel heat exchanger as the solar collector. Mini-channel heat exchangers, also called micro-channel heat exchangers, have been successfully utilized in the automotive, residential air conditioning, and electronics cooling industries due to their improved performance and compact size compared to typical round-tube plate-fin heat

exchangers. Approximately 35% of natural gas used in California homes is used to heat water. In a 2003 study published by the CPUC, solar water heating was found to have the highest potential of all applications to reduce use of natural gas. The typical first cost of $6700 for a solar water heater is the primary barrier to greater adoption of solar water heating. Developing more cost-effective collectors will contribute to reducing this cost barrier. This project has the manufacturing support of a start-up company, SunTherm Energy, which is focused on building and marketing these mini-channel solar collectors if they prove to be practical. The research team has extensive practical experience in the heat exchanger industry. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by reducing the first-cost barrier of solar water heating.

Budget Category: Technical Innovation in Buildings & Community

Project 5: Improving HVAC Electric Motor Systems in Buildings
PI: Sadrul Ula, UC Riverside
Rank: 1
Amount: $423,500

Project Summary:
The goal of this 18-month project is to reduce electrical energy use by HVAC drive motors in California buildings. While HVAC motors consume large amounts of electrical energy, the emphasis on motors in engineering schools has waned over the years, as faculties have focused on electronics and computer applications. Graduate engineers well trained in the multi-disciplinary applications of motors are rare. As a result, engineering firms tend to use large factors of safety in selection of motors, resulting in less than optimal efficiency. There are no in-state independent testing laboratories for motors in California. This project will begin to address this situation by starting a program for motor research and training for engineering students at UC Riverside. The contractor would undertake the following three objectives under this contract:
Measure and document large HVAC motor energy use under actual operating conditions in various buildings using graduate and undergraduate students.
Set up a motor testing facility at UC Riverside, the first of its kind in California, to test both new and old HVAC motors and variable speed drives,
Evaluate HVAC motor-sizing software used by architecture and engineering firms for inflated safety factors.
The project has the support of Southern California Edison, Brithinee Motors of Colton California, and will enlist other commercial partners as it develops. The team has extensive experience in motors and has the institutional support of UCR College of Engineering Center for Environmental Research and Technology. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by helping transform the HVAC industry and reducing energy used by HVAC motors.

Project 6: Improved HVAC Through Standards for Technician Instruments
PI: Kristin Heinemeier, UC Davis WCEC
Rank: 2
Amount: $305,604 (plus $50,000 in-kind)

Project Summary:
Properly addressing common airflow and refrigerant charge problems in small air conditioning (AC) systems can typically save 30% of AC energy, but a recent CPUC study of AC tune-up programs determined that only 20-30% of this potential was actually obtained. The study concluded that part of the problem was instrument inaccuracy and improper use by AC technicians. The goal of this project is to identify and promulgate suitable instrumentation for HVAC technicians and proper training for use of these instruments. This goal will be accomplished by
Evaluating and leading a standards process for test equipment,
Development and demonstration of best practices, and
Dissemination of information through a website and publications.

This information will affect the choice of instruments and measurement methods, enabling technicians to better install and maintain HVAC systems to achieve significant energy savings. This project will have a significant impact on the energy performance of residential and small commercial building HVAC by providing information to manufacturers, contractors, technicians, utility program managers and policymakers about appropriate tools and techniques. The Western Cooling Efficiency Center will leverage their relationship with community colleges programs where much of the technician training takes place. Information and curriculum material will be posted on the WCEC website for this purpose. Estimated savings on new and existing HVAC in residential and small commercial due to this project are 170 GWh/year ($43M/year), with at least 3,300 jobs created. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by helping transform the HVAC industry in California.

Project 7: Saving Energy in Buildings With Adaptive Lighting Systems
Principal Investigator: Michael Siminovich, UC Davis CLTC
Rank: 3
Amount: $275,017
Project Summary:
The goal of this 30 month project is to develop retail lighting solutions that ensure lights are off or dimmed when no occupants are present or when there is available daylight, a concept known as adaptive lighting. Lighting is responsible for 50% of electricity used in retail buildings. This project will reduce lighting energy use by indentifying which spaces in retail buildings are most suitable for adaptive lighting and then developing and testing systems, using either existing or experimental lighting devices. The California Lighting Technology Center (CLTC) has developed adaptive lighting systems for other applications that have already been successfully transferred into commercially available products. CLTC has close relationships with manufacturers, many of whom are interested in this project, and an excellent track record of market-connected product development and improvement. CLTC will also be active in developing standards for Title 24. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by substantially transforming the retail lighting industry and has the specific support of Southern California Edison.

Project 8: Wireless Measurement Tools for Better Indoor Environments
PI: Tom Webster, UC Berkeley Center Built Environment
Rank 4
Amount: $385,453
Project Summary:
The goal of this 24 month project is to promote better indoor environmental quality by developing a ready-to-use toolkit for making an snapshot' environmental measurements or extended monitoring. You cannot manage what you cannot measure' is a dictum as applicable to building environments as anything else. While technology for measurement of energy is standardized, measurement of environmental attributes is much less so. These attributes include mean radiant temperature, temperature stratification, humidity, lighting, acoustics, and air quality. The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) are heavily promoting a Performance Measurement Protocol (PMP), for which no standardized package of measurement equipment and software analytical tools exists. Center for the Built Environment (CBE) has already developed a sophisticated commissioning cart' which employs wireless sensors and communications for commissioning HVAC systems. The proposed toolkit would build on the existing cart design to allow objective environmental measurements to implement PMP measurements. Reference specifications for the PMP Toolkit would be publicized to stimulate commercialization of the concept. Support for this project has been expressed by a number of designers and commissioning agents, including WSP Flack and Kurtz, Syska-Hennessy, and Quantum Energy Services. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b)(2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by producing zero-energy commercial buildings by helping to identify efficient ways to provide high quality indoor environments.

Project 9: Saving Energy in Buildings With Adaptive Envelope Systems
PI Konstantinos Papamichael, UC Davis CLTC
Rank: 5
Amount: $274,999

Project Summary:
The goal of this 30 month project is to reduce energy use in retail buildings by promoting widespread adoption of envelope solutions which actively manage ventilation and daylight, in coordination with electric lights and HVAC systems, a concept known as an adaptive envelope system. Windows and skylights can be energy assets, letting in daylight and ventilation when needed, reducing the need for electrically driven solutions. Without active controls though, they can create glare, overheating, or overcooling. Active control systems for envelope features are rarely used in commercial applications. This project will help address this problem by developing, testing and integrating cost effective solutions to optimize the integration of windows, skylights and shading systems with HVAC and electric lighting systems. The research team will develop a package of systems that incorporate advanced control components and algorithms that will reduce energy and peak demand savings. CLTC

has close relationships with manufacturers interested in this project, and Southern California Edison has also expressed utility support. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by developing technology to reduce the energy use of retail buildings.

Budget Category: IAW PIER-NG

Project 10: Enabling Renewable Fuels Through Flexible Burners
Principal Investigator: Vincent McDonell, UC Irvine
Rank: 1
Amount: $357,500

Project Summary:
The goal of this 36 month project is to increase the use of bio-fuels for industrial purposes by developing more sophisticated metrics for characteristics of natural gas and renewable fuels for use in industrial steam and hot water generation. The standard metric for natural gas is the Wobbe index, but this index is inadequate for accurately predicting the interchangeability of various renewable bio-fuels. A number of important parameters need to be considered besides those appearing in the Wobbe index (W), including chemical kinetics, ignition times, both laminar and turbulent burning velocities, and transport properties of the flames. The work proposed will carry forward and evolve the interchange parameters developed and apply them to an experimental boiler facility. The work will also incorporate sensors and controls to demonstrate the ability to adjust for fuel composition in a robust manner and allow the system to optimize itself for low emissions while maintaining overall efficiency and performance. This project promotes the policy goals contained in the Integrated Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by increasing the use of renewable combustion fuels.

Budget Category: Renewables PIER-NG
Project 11: Gasification of Almond Shell Biomass for Natural Gas Replacement
Principal Investigator: Robert Cattolica, UC San Diego
Rank: 1
Amount: $463,853

Project Summary:
The goal of this 24 month project is to produce and use clean fuel gas from the gasification of almond shells to facilitate the development of 1.5 MW combined heat and power plants to eliminate natural gas use by the Californial almond industry. Specific project objectives include: (1) optimization of the gasification of almond shells to achieve 80 percent energy efficiency in the production of heat and power, (2) advancd gas cleaning to provide high quality gas and (3) reduce power porduction exhaust emission levels below state requirements. The use of 800,000 tons/year of almond shell biomass has the potential of replacing up to 12.5 billion cubic feet of natural gas and generating up to 80 MW of power that could reduce the industry's energy cost by up to $100 million/year. This project has the potential of helping the almond industry become self sustaining in terms of heat and power while reducing green house emissions. This project promotes the policy goals contained in the Integrated

Energy Policy Report (IEPR), Public Resources Code Section 25620.1 (b) (2), AB-32 and the CPUC/CEC Energy Efficiency Strategic Plan by increasing the use of renewable combustion fuels.

Justification and Goals

The projects in this proposed contract address the following goals:

- Public Resources Code Section 25620.1. (a-c):
  This project is part of a "full range of research, development, and demonstration activities that are not adequately provided for by competitive and regulated markets," and "will develop, and help bring to market increased energy efficiency in buildings, appliances, lighting, and other applications beyond applicable standards, and that benefit electric utility customers," and "will advance energy science or technologies of value to California citizens..."

- Public Resources Code Section 25401:
  The section requires the Energy Commission to "carry out studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomical uses of energy." This research will lead to such reduction through the opportunities identified for building and appliance standards.

- These projects are also consistent with the Integrated Energy Policy Report, AB 32 and the CPUC's Energy Efficiency Strategic Plan which specifically identifies the need for lighting research to meet the state's policy goals for energy efficiency.

- The projects also address the following specific elements of the 2009 natural gas research plan which was presented to, and accepted by, the California Public Utilities Commission:

1. Advanced distribution systems for residential heating. (Project 1)
2. Natural gas and waste heat-driven cooling, heating and power systems for commercial buildings. (Projects 2 and 3)
3. Energy efficient hot water generation and distribution. (Projects 2, 3 and 4)
4. Natural gas efficiency research for industrial and institutional use (Projects10 and 11)

This will be accomplished by:

Increasing use of renewable fuels in CHP applications
Increasing energy efficiency in buildings and appliances